Stem growth disorder and xylem anatomy modifications during esca pathogenesis in grapevines

Authors: Ninon DELL'ACQUA[1], Gregory A. GAMBETTA[2], Nathalie FERRER[1], Pauline THEODORE[1], Chloé E. L. DELMAS[1]

[1]*UMR SAVE, 71 avenue Edouard Bourlaux, F-33140 Villenave d'Ornon, France*

[2]*UMR EGFV, 71 avenue Edouard Bourlaux, F-33140 Villenave d'Ornon, France*

*Corresponding author: *ninon.dell-acqua@inrae.fr*

Abstract:

Context and purpose of the study - Esca is a grapevine vascular disease with detrimental consequences on vineyard yield and longevity. Recently, esca leaf symptom development has been shown to result in the occlusion of xylem vessels by tyloses in leaves and stems, leading to hydraulic failure. However, little is known regarding the response of xylem anatomy and stem growth to esca in different varieties . Here we studied the impact of esca leaf symptom development on grapevine physiology, stem growth, and xylem anatomy in two widespread cultivars, Cabernet sauvignon and Sauvignon blanc.

Material and methods - To study esca under controlled conditions and since pathogen inoculations are not able to reproduce esca leaf symptoms, we used an original experimental design made of infected plants uprooted from two vineyards in France and transplanted into pots. Two grape varieties were compared in this experiment: 9 Sauvignon blanc grafted on Fercal and 10 Cabernet Sauvignon grafted on 101-14MGt, all 19-20 years old. Multiple traits were monitored during 3 months in the greenhouse: the plant-water relation at leaf and whole-plant scales (by monitoring whole-plant and leaf gas exchange, predawn and midday water potentials), stem growth (using dendrometer measurements), xylem anatomy (optical microscopy of stem and midrib cross sections) and esca symptom expression during the season.

Results - The onset of leaf symptom expression led to a decrease in gas exchange at whole plant and leaf scales in both Cabernet sauvignon and Sauvignon blanc. However, plants were able to produce new secondary green leaves after symptom development. Esca significantly impacted the growth of symptomatic stems, by altering the shrinkage phase in both grape varieties. A thorough study of the xylem anatomy identifying individual vessel area, position within the stem cross-section, and level of occlusion demonstrated that the percentage of theoretical loss of conductivity (PLC_{th}) due to tyloses was higher in esca than control stems with a gradual decrease in PLC_{th} over the season for both varieties. In the most exterior xylem vessels (i.e. produced the latest) this observation is associated with a reduction in theoritical specific hydraulic conductivity (k_{ts}) of non occluded vessels in esca symptomatic Sauvignon blanc plants. At the end of the season, esca symptomatic stems produced more vessels and in higher density, but they were smaller than in control stems. Finally, this study highlighted the impact of esca disease on the physiology, growth, cambial stem activity and thus the ability to regrow with the support of new xylem vessels, for two different varieties.

Keywords: Grapevine, Vascular disease, Gas exchange, Dendrometer, Quantitative anatomy